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Fishery Facts 8

National Oceanic and Atmospheric Administration / National Marine Fisheries Service

Sanitation Recommendations for Fresh and Frozen Fish Plants

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J. PERRY LANE

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FISHERY FACTS- 8

sanitation recommendations for fresh and frozen fish plants

J. PERRY LANE

SEATTLE, WA
November 1974

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ABSTRACT

The problem of sanitation in fish-processing plants is receiving increasing attention from Federal and State regulatory agencies, as well as private industry. This article covers recommended guidelines that can assist the processors of fresh and frozen fish in evaluating their existing sanitation practices or in establishing new ones.

SANITATION RECOMMENDATIONS FOR FRESH AND FROZEN FISH PLANTS

J. PERRY LANE[1]

INTRODUCTION

In recent years, the spotlight of public attention has focused on the operations of fish processors. That this spotlight has indeed shone on fish processors is evidenced by the successions of bills on compulsory inspection and regulation of the seafood industry that have recently been introduced in the Congress of the United States. These bills are concerned primarily with protecting the consumer from health hazards and aesthetically undesirable practices. For the most part, the need for protection results from problems in sanitation.

The guidelines presented here represent an attempt to assemble the existing requirements for food plants in general and to relate them to fish plants in particular. A processor of fresh fish may find that many of the suggestions are difficult to put into practice without rebuilding his plant. These suggestions or closely related ones, however, are actual requirements for some food processors, such as packers of meat and poultry and producers of dairy products. So, similar types of regulations are likely to be forthcoming for the fishing industry. These guidelines thus can serve as a preview of some of the things that may be required.

Every processor should be thoroughly familiar with existing state and local Public Health regulations. In addition, the Federal Food, Drug, and Cosmetic Act is the overall basis for regulations of all food processors. Two sets of federal regulations in particular have a direct bearing on the operation of processing plants, and every plant owner should become thoroughly familiar with their contents, if he has not already done so. The first is the U.S. Food and Drug Administration (FDA) Current Good Manufacturing

[1]Northeast Region, National Marine Fisheries Service, NOAA, 14 Elm Street, Gloucester, MA 01930.

Practices (Sanitation) in Manufacturing, Processing, Packing, or Holding, published in the Federal Register, Volume 34, Number 80, 26 April 1969. The second is the Occupational Safety and Health Act (OSHA) of 1970, and the regulations promulgated for its enforcement. This Act is administered by the U.S. Department of Labor. Of particular interest, since it touches directly on sanitation, is Part II of the Occupational Safety and Health Standards published in the Federal Register, Volume 37, Number 202, 18 October 1972.

Apart from any regulatory activities, another powerful factor now at work suggests that the fish processor should take a lively interest in sanitation. This factor is the consumer's increased awareness of quality factors and processing conditions. With the elimination of the captive Friday market for fishery products, seafoods have to compete on their own merits for the consumer's food dollar. The fishing industry, therefore, is fortunate in having a product that is both nutritious and flavorful when it is handled properly.

The purpose of these guidelines is to provide the processor with suggestions that will help him to give the consumer the quality that makes fish a desirable food. Some of the suggestions can be put into practice immediately, whereas others, such as those that involve building construction, can aid in long-range planning for expansion or remodeling. Every segment in the chain of distribution from the sea to the consumer must ensure that it delivers fish that is as close as possible to the quality that it received. By paying proper attention to sanitation in his plant, the processor will contribute greatly toward maintaining the quality of the fish.

The first part of the guidelines presented here gives recommendations for the plant, the second part gives recommendations for the processing of the fish.

I. PLANT RECOMMENDATIONS

In this part of the guidelines, we are concerned with plant premises and plant construction.

A. PLANT PREMISES

Both the location of the plant and the plant surroundings are important factors in a sanitary fish-processing operation.

1. Location

a. If possible, locate the plant away from such sources of odors, dust, and air contamination as refineries, chemical plants, and dumps. [See

Thompson and Farragut (1969) for an example of a problem that can be encountered at certain plant locations.]

b. Locate the plant where it will be accessible to a supply of potable water and to a sewage system. (Here potable means that the water supply meets the criteria in the current edition of the "U.S. Public Health Service Drinking Water Standards.")

c. Locate the plant in a well-drained area.

d. Locate the plant where it will not be subject to flooding by exceptionally high tides. Should it become flooded, processing should be discontinued until after waters have receded and the building cleaned and properly sanitized.

e. Pave the entrance roadways.

f. Physically separate the plant from any plants that process nonhuman food.

2. Surroundings

a. Keep the surroundings free of unkempt vegetation capable of harboring insects or vermin.

b. Keep the grass and shrubs trimmed and neat.

c. Keep refuse areas separate from the processing plant.

d. Do not pile waste containers and fish boxes, for example, in the open area outside of the plant.

B. PLANT CONSTRUCTION

In the construction of the plant, we are concerned with both the facilities for processing the fish and the facilities for the employees.

1. Processing Facilities

We can divide the processing facilities into what we might call the basic facilities and the equipment used in the plant operations—a. Basic facilities.—What do we mean by basic facilities? We consider the basic facilities to be building construction, water supply and waste disposal, refrigeration, and lighting and ventilation.

(1) Building construction

Construct the buildings large enough to accommodate the operation

without hampering sanitary cleanup. In areas where food is processed or stored, use building materials that will not absorb water, are easily cleanable, and resistant to wear and corrosion.

Keep all exterior openings such as doors, windows, and vents in good repair, and equip them with screens or other devices, such as air curtains, to prevent the entrance of insects, rodents, and other animals.

In this section, we consider the following subjects specifically: floors, walls, ceilings, and entrances.

(a) Floors.—Two aspects of floor construction are of concern: the floors themselves and their drains.

[1] Floor construction.

Construct the floors of hard material such as waterproof concrete or tile. Do not make the floors extremely smooth. To prevent the workers' slipping on the floors, give the concrete a rough finish or use embedded abrasive particles. Water-based acrylic epoxy resin makes a durable nonabsorbent floor that is easy to keep clean, but care must be taken to add material to make the surface rough or it will be slippery when wet.

Apply an approved latex synthetic resin base on concrete or mortar floors to increase resistance to corrosion.

Install drainage coves at the junctures of the floors and walls.

[2] Floor drains.

In any area where water is used, install at least one drainage outlet for each 400 square feet of floor space.

Give floors a slope of ¼ inch per foot to drainage outlets.

Make the slope uniform with no dead spots.

Provide drains with traps.

In areas where the water seal in the traps is likely to evaporate unless replenished, provide the drains with removable metal screw plugs.

Construct drainage lines of galvanized iron or steel.

Polyvinyl chloride (PVC) tubing can be used if permitted by state and local codes.

Use drainage lines with an inside diameter of at least 4 inches.

Vent drainage lines to outside air.

Screen the vents to prevent rodents from entering the plant.

Do not connect drainage lines from toilets to other drainage lines; be sure that the drainage lines from toilets discharge directly into a sewage system.

(b) Walls.

Make interior walls smooth and flat.

Maintain the walls in good repair.

Construct the walls of nonabsorbent (impervious to water) materials, such as glazed brick, glazed tile, smooth-surfaced portland-cement plaster, or other nontoxic nonabsorbent material (Fig. 1). [Poured concrete walls are satisfactory if they are troweled to a smooth finish. Marine plywood or metal walls (stainless steel, aluminum, or galvanized iron or steel) also are satisfactory if seams, nail holes, and junctions of floors, walls, and ceilings are watertight.]

Do not allow the supporting structures of walls to be exposed.

If painted, the paint selected should be a light color and not be lead based.

(c) Ceilings.

Place ceilings in work areas in such a way as to prevent foreign material from falling from overhead pipes, machinery, and beams onto exposed fishery products.

Make ceilings 10 feet high or higher in work areas.

Construct ceilings of portland-cement plaster, large-size asbestos boards with joints sealed with a flexible sealing compound, or other suitable material impervious to moisture.

(d) Entrances.—In this section, we are concerned with the construction of doorways and doors and with pest control.

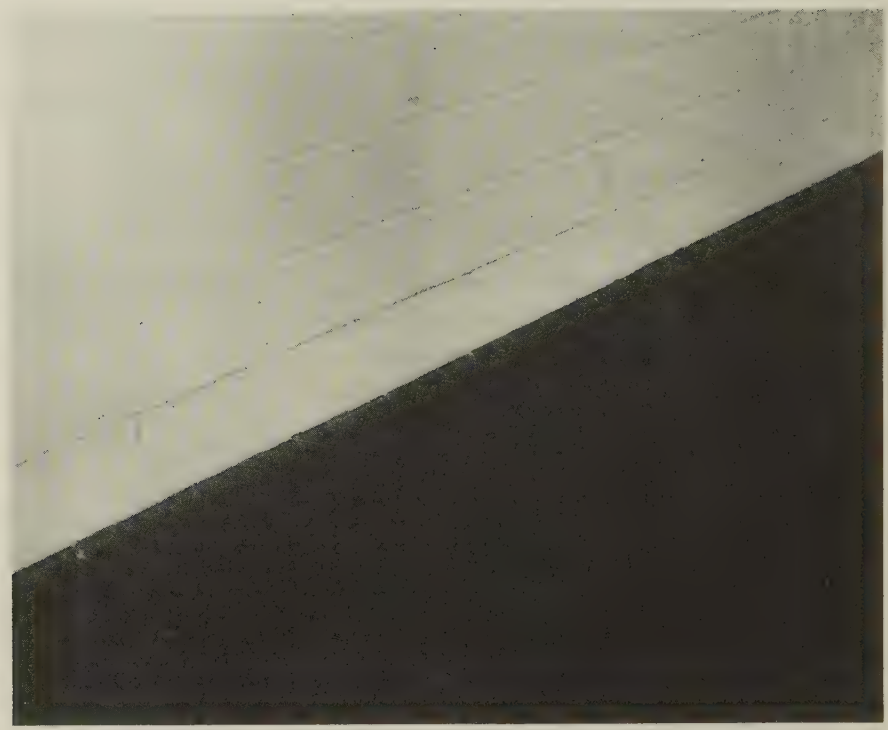

Figure 1.—Tile walls in the processing area provide an attractive appearance and are easy to keep clean.

[1] Construction of doorways and doors.

Make doorways through which products are transferred on handtrucks, dollies, or forklifts at least 5 feet wide.

Make the doors and frames of rust-resistant metal or of wood sheathed completely with rust-resistant metal having tightly soldered or welded seams (Fig. 2).

[2] Pest control.—Both insects and rodents need to be controlled to prevent contamination and destruction of fishery products.

[*a*] *Insect control.*

Screen and maintain in good repair all windows, doorways, and other openings that would admit flies and other insects.

Double entry screened doors are recommended for outside entrances.

Provide "fly-chaser" fans and ducts over outside doorways in the food-handling area.

Limit the use of insecticides to those that are approved by the U.S. Food and Drug Administration.

Figure 2.—Self-closing doors leading from loading platform to cooled working area help prevent temperature increase. Note doors entirely metal sheathed.

In the application of insecticides, take care to prevent their contact with fish or other food products and with any working surfaces that come in contact with food products.

[*b*] *Rodent control.*

Provide all exterior openings with screens that are rodent-proof as well as insect-proof (Fig. 3).

Except for solid masonry walls constructed or lined with such materials as glazed tile or brick, imbed expanded metal or wire of ½-inch mesh or less in the junction of walls and floors.

Routinely inspect beams and storage areas for evidence of rat runways and nests.

If you find signs of rodents, call in a professional ex-

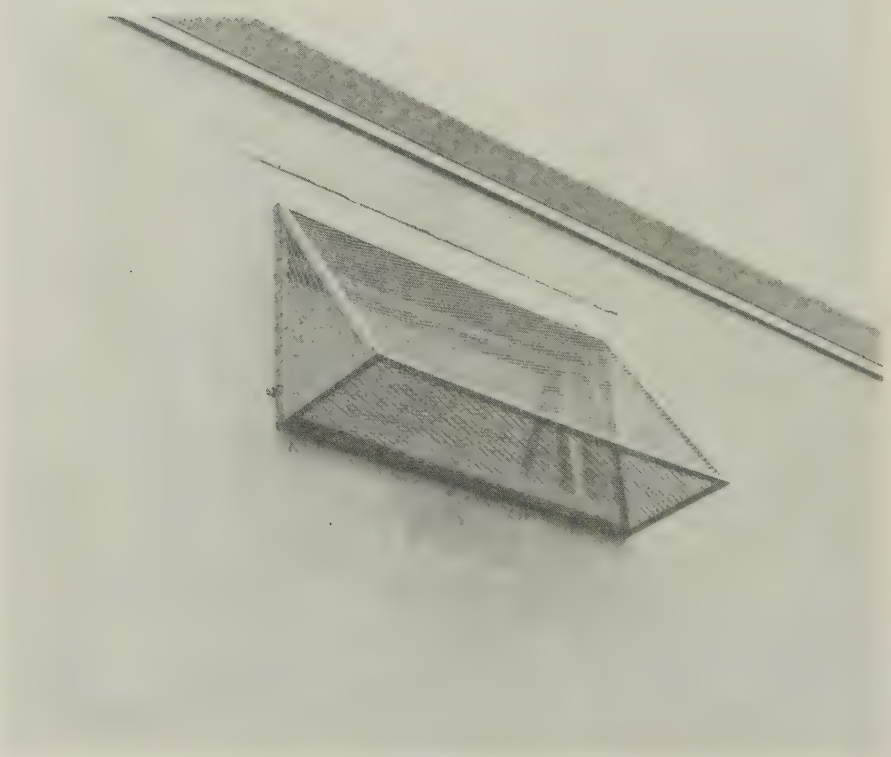

Figure 3.—Heavy mesh screening over windows to dry storage area prevents entry of birds, rodents, and other pests.

terminator. *Exercise extreme care so as not to contaminate fish or work surfaces with rodenticides.* Rodenticides which are highly toxic to humans should not be stored in processing plants and should not be used except under the supervision of a licensed pest-control operator or other qualified specialist. (Rodenticides which have a low toxicity for humans should be identified, stored, and used in such a manner as to prevent contamination of the product and to cause no health hazards to employees.)

Only those pesticides which have been properly registered with the U.S. Department of Agriculture and the State Department of Agriculture and approved for the purpose by the state regulatory authority should be used; such pesticides should be used in accordance with the manufacturer's directions and should be so handled and stored and used as to avoid health hazards to employees and product contamination.

[c] *Bird control.*

Sea gulls are frequently found in the vicinity of fish plants. Since sea gulls are known to be carriers of salmonella, precautions should be taken to prevent their access to fish and other raw materials. Outside storage areas should have a roof and be screened in. Fish should *never* be left in open boxes or carts outside the plant where birds and vermin can come in contact with them.

(2) Water supply and waste disposal.

(a) Plumbing.

Plumbing should be installed in compliance with State and local plumbing ordinances, or be substantially equivalent to the recommendations contained in the current "American Standard National Plumbing Code."

There should be no cross-connections between the approved pressure water supply and water from a nonapproved source, and there should be no fixtures or connections through which the approved supply might be contaminated by back siphonage.

Fixtures, ducts, and pipes should not be so suspended over

working areas that drip or condensate may contaminate foods, raw materials, or food-contact surfaces.

Plumbing facilities and equipment should be so constructed and so located as to permit no splashing of water onto processing areas or product.

(b) Water supply.

Use only potable water for cleaning fish in any form or for cleaning any surface that could come in contact with food products or that could contribute to their contamination. Seawater may still be used for the fluming of whole or dressed fish if the source meets local health requirements and if the water itself meets the microbiological requirements of the "Drinking Water Standards." However, this may not be permitted in the future as it results in excess effluents.

If water from public water supplies is used, test it against the "Drinking Water Standards" at least every 6 months to ensure that no in-plant contamination has occurred.

If water from a private well is used, make sure that the source is free of contamination. Test the water for purity monthly.

If chlorinators are required to ensure a continuous supply of potable water, use an automatic type equipped with warning devices to signal when it is not functioning properly.

Throughout the plant, provide both hot and cold water under adequate pressure and in quantities sufficient for all operating needs. Install all equipment so that liquids will not be back siphoned into lines carrying potable water.

In general, except as provided above, do not use nonpotable waters in the plant. If such water is used for fire protection, steam lines, and the like, supply it in separate lines with no cross connections with potable water lines. Clearly mark nonpotable water lines and outlets, and instruct all plant personnel that nonpotable water can be a *deadly hazard* if it comes in contact with food products.

An automatically regulated hot-water system should be provided with sufficient capacity to furnish water at a constant temperature of at least 130°F during all hours of plant operation and plant cleanup. Hot- and cold-water outlets should be provided at each sink compartment.

(c) Waste disposal.

Ensure that waste-disposal systems meet the pertinent requirements given under the section on "Floor drains" on page 4.

If permitted by local ordinances, discharge plant wastes into the municipal sewer system.

If you use a private septic tank or sewage disposal system, ensure that it is efficiently designed and operated so as not to produce objectionable conditions.

Any private sewage-disposal facilities utilized should be constructed and operated so as to comply with state and local requirements; privies should be permitted only where water-carriage systems are infeasible. Any newly constructed individual water-carriage systems should be at least equal to the recommendations contained in the current "Manual for Septic Tank Practice" (U.S. Public Health Service, 1969).

Do not discharge gurry and processing waste or plant sewage directly into harbors or other water areas without explicit written permission of Municipal or State Public Health Authorities. The Environmental Protection Agency (EPA) is responsible for developing criteria for all waste discharges. Standards for fish processing plants will be prepared in the near future and these should carefully be consulted as soon as they are available.

Have any sewage-disposal facilities approved by the appropriate health authorities. Get the approval in writing, indicating when the facilities were last inspected.

Store gurry and other fish waste that cannot be carried by a sewage-disposal system in insect-proof and rodent-proof containers outside the plant or in physically segregated refrigerated rooms that are not used for any food products (Fig. 4).

Empty or remove unrefrigerated gurry from the plant premises at least once every 8 h. If the containers are to be reused, wash and sanitize them before using them again (Fig. 5).

Do not store gurry in refrigerated rooms above freezing (32°F) for more than 48 h. Dispose of frozen gurry as expeditiously as possible, and do not keep it on the premises for more than a week.

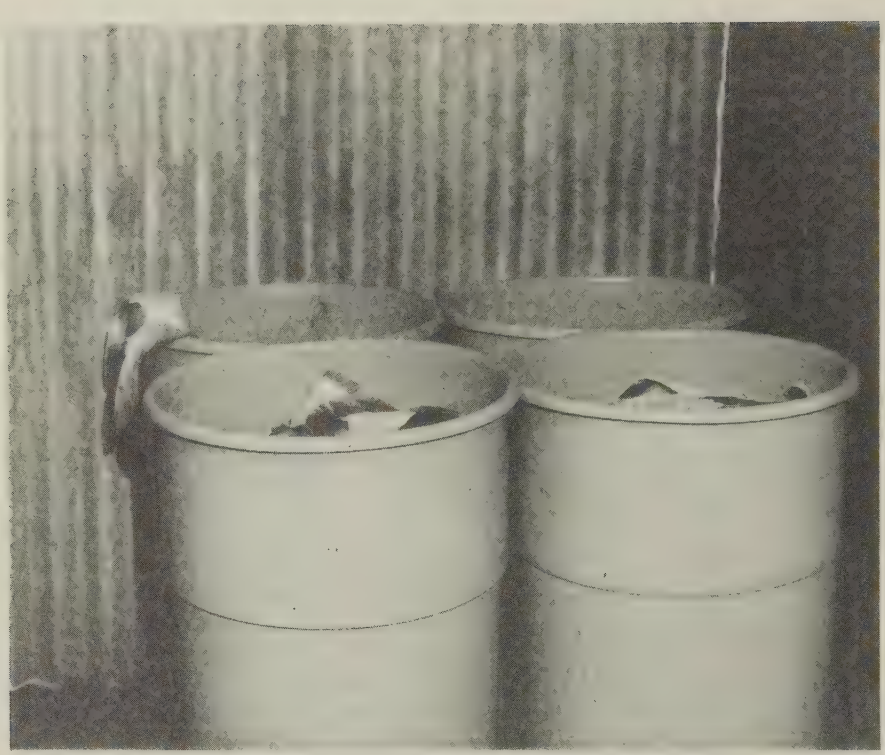

Figure 4.—Fish waste stored in clean plastic containers in a separate refrigerated area.

(3) Refrigeration.

Make the refrigeration adequate to handle raw materials, as will be discussed under the section on "Receiving raw materials," page 32.

Provide a temperature of 50°F or less in work areas where fresh fish are processed (Fig. 6); although 40°F is preferable for the product, it may cause worker problems. Occupational Safety and Health Act (OSHA) authorities should be consulted on the latter aspect.

Maintain freezer rooms at −10°F or lower for the storage of the finished products. For the initial freezing of finished products, use plate freezers or blastfreezing tunnels that provide contact temperatures of −20°F or lower.

If refrigeration wall coils are used in chilling rooms, provide, beneath the coils, a drip gutter of concrete or other moisture-impervious material properly connected with the drainage system.

Provide overhead refrigeration coils or plates in chilling rooms with insulated drip pans connected to drains placed beneath (Fig. 7).

Use potable water in making ice used for holding fresh fish or other food products. Store, transport, and handle the ice in a sanitary manner. Do not reuse ice after it has been in contact with fish or fish products or with contaminated work surfaces or holding areas.

Refrigeration rooms should be of sanitary construction with an im-

Figure 5.—Fish waste from the filleting line is conveyed directly to plastic containers which are used only for this purpose.

Figure 6.—Work areas where fresh fish are processed should be chilled to at least 50°F.

pervious floor graded to drain quickly. The rooms should be so constructed that they would not receive drainage from other portions of the plant.

The refrigerated storage area should be large enough and so constructed that a full day's production, with ice, if necessary, can be conveniently stored. The storage area should be equipped with an accurate thermometer.

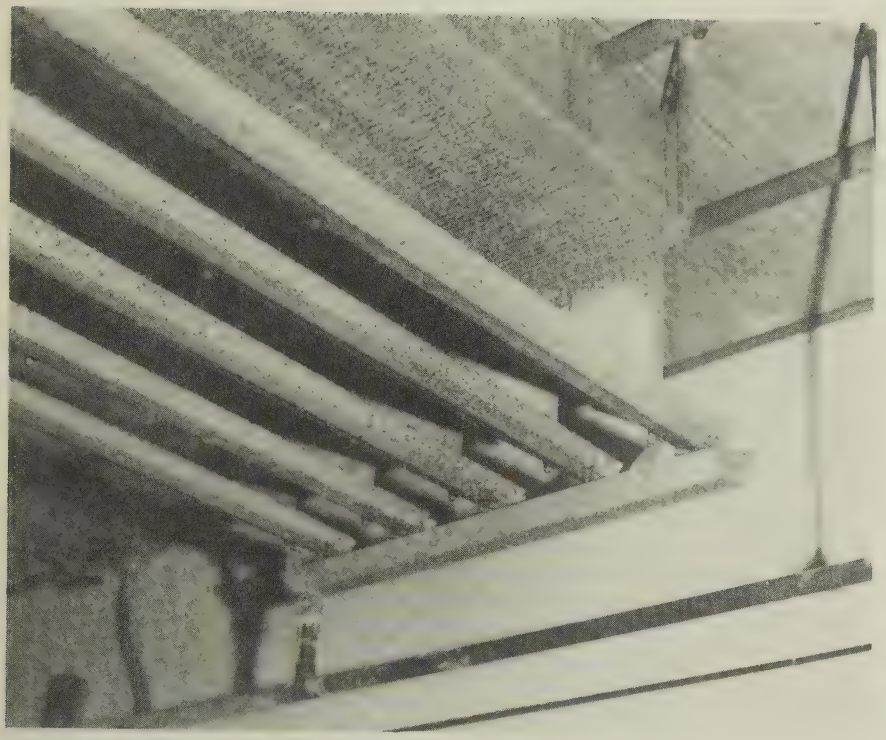

Figure 7.—Drip pans beneath refrigeration coils prevent condensate from dropping on personnel and products.

Ice should preferably be manufactured in the plant; otherwise, it should be obtained from an approved source (Fig. 8). Packers purchasing crushed ice should secure it from dealers who handle, crush, and deliver it in a sanitary manner.

Ice bins should have smooth, impervious ice contact surfaces and should be so constructed and located that the bottom is above the level of the adjacent floor and drains away from the unused ice.

Block ice should be properly stored to avoid contact with contaminated surfaces and should be thoroughly washed on an elevated metal stand or grating with a hose provided for this purpose before it is placed in the crushing machine. A corrosion-resistant container should be provided to catch the crushed ice falling from the crusher. (Where the crusher is located in a protected portion of the refrigeration room, this container is not required.)

All facilities and equipment employed in handling and/or preparing ice for use should be used for no other purpose and should be

Figure 8.—An ice-making plant on the premises assures a steady supply of ice.

cleaned each day the plant is in operation. Shovels should be hung or stored in a protected manner when not in use.

Where it is necessary to have ice in the packing room, a metal-lined container or compartment of sanitary construction should be provided for the sole purpose of storing ice manufactured in the plant, purchased crushed ice, or block ice that has been crushed in the

plant; except that clean wooden barrels may be used for this purpose.

(4) Lighting and ventilation.—Both proper light and ventilation are important in maintaining sanitary surroundings and comfortable employee working conditions.

(a) Lighting.

Provide unrefrigerated workrooms with direct natural light where possible. In windows and skylights, use uncolored glass having a high transmissibility of light.

Use heat-absorbing (blue) glass to reduce glare in windows and skylights that are exposed to considerable sunshine.

In a workroom, make the glass area at least one-fourth the size of the floor area.

Provide well-distributed artificial lighting of good quality where natural lighting is not available or sufficient. In work areas, make the overall intensity of artificial illumination not less than 100 footcandles.

Artificial light should be at least 50-footcandle power in all storage refrigerated rooms and 25 footcandles in toilet rooms and privies.

Lights over processing areas should be covered by clear shields to prevent glass from falling into the food products if a light bulb should break.

In candling for parasites, use lights that provide at least 50 footcandles of illumination.

Cover the light by a clean glass surface so arranged as to prevent any moisture from seeping down to the light fixture.

(b) Ventilation.

Provide sufficient natural or mechanical ventilation to control visible molds, objectionable odors, or excessive condensates. The flow of air should be such that it will minimize the possibility of air-borne contamination.

Provide ventilation by means of windows, skylights, mechanical air conditioning, or a fan-and-duct system.

Supply mechanical ventilation in refrigerated workrooms where natural ventilation is lacking.

Locate fresh-air intakes so that the air is not contaminated with odor, dust, or smoke.

Where mechanical systems are used as the sole means of ventilating nonrefrigerated workrooms and employee welfare rooms, use systems that can provide at least six complete changes of air per hour.

Install the ventilation systems so that air does not move from raw material or preparation rooms into processing or packaging rooms.

b. Processing equipment.—Having considered the basic processing facilities, we should now consider the processing equipment. Design all equipment and utensils of such material and construction that they are smooth, easily cleanable, and durable, and that any surfaces in contact with the product are free from pits, cracks, and scale. In addition, design and construct the equipment and utensils to prevent contamination of fish and fishery products with fuel, lubricants, metal, and other extraneous material. All equipment should be installed and maintained in a manner that will facilitate the cleaning of the equipment itself and all surrounding areas.

(1) **New equipment.**—Ensure that new equipment conforms to the applicable standards cited in the AFDOUS Food Code (Association of Food and Drug Officials of the United States, 1962) and with any more recent revisions of these standards.

(2) **Materials.**

Use stainless steel as far as possible in all metal equipment that will come in contact with seafood. In general, do not use galvanized metal, because it is not sufficiently resistant to the corrosive action of food products, cleaning compounds, and salt water and brine. If you must use galvanized metal for economic reasons, use it for such purposes as the construction of waste containers. If galvanized metal is used, make sure that it has the smoothness of high-quality commercial dip.

Where fish are handled, make cutting boards or table tops of synthetic rubber-thermoplastic polyethylene or of other hard, nonporous, moisture-resistant, synthetic material. Wood cutting boards should not be used because they are virtually impossible to keep

Figure 9.—A synthetic cutting board is much easier to keep clean than are wooden boards.

clean (Fig. 9). Cutting boards should be easily removable for cleaning and should be kept in a smooth condition.

Do not use copper, cadmium, lead, painted surfaces, enamelware, or porcelain on surfaces in contact with the product. (The first three materials are toxic, and the last three may chip or flake off into the product.)

Make certain that any plastic materials and resinous coatings that you use are abrasion and heat resistant, shatterproof, and nontoxic, and that they do not contain any material that will contaminate the fish or fishery products.

(3) **Conveyor belts.**—Make conveyor belts of moisture resistant material that is easy to clean, such as nylon, hard-finished rubber, or stainless steel.

(4) **Equipment design.**—Design the equipment in such a way as to eliminate dirt-catching corners and inaccessible areas. Install

equipment capable of rapid and complete breakdown for cleaning. To facilitate cleaning, use sealed or closed steel tubing rather than angle or channel iron.

(5) **Motors, bearings, and switches.**

On food-handling equipment, locate all motors and oiled bearings in such a way as to prevent oil or grease from contacting the product.

Protect motors and switches from contact with water.

Raise motor mounts high enough to permit you to clean under them and between them.

Protect drivebelts and pulleys with guard shields that can be readily removed for cleaning.

(6) **Welding.**—Make all welding within the product area continuous, smooth, and even, and as nearly flush with adjacent surfaces as possible. To provide a smooth surface, welds should be polished.

(7) **Stationary equipment.**

Install all parts of stationary, or not readily movable, equipment at least 1 foot from walls and ceilings to provide access for cleaning.

Mount this type of equipment at least 1 foot above the floor, or else have a watertight seal with the floor.

(8) **Water-wasting equipment.**—Install water-wasting equipment — such as flumes, brining tanks, and wash tanks — in such a way that waste water from the equipment is delivered through an uninterrupted connection into the drainage system without flowing over the floor.

(9) **Cutting tables.**—Turn up the edges, at least 1 inch, of cutting tables or other equipment having water on the working surface.

2. Employee Facilities

Having considered the processing facilities, we now consider the facilities for the employees. To get plant personnel to recognize the importance of sanitary practices and to obtain their full cooperation, make proper provision for their personal needs. Considered here are the dressing rooms, toilet facilities, hand-washing units, and eating facilities.

a. Dressing rooms.

Provide separate dressing rooms for employees of each sex.

Separate the dressing rooms from the toilet and work areas.

Ventilate the dressing rooms, and provide receptacles for the disposal of cigarette stubs and other wastes.

Provide each employee with a metal locker that is at least 15 by 18 by 60 inches. Place lockers on legs 16 inches high to enable you to clean all areas of the floor.

b. Toilet facilities.

At least 25-footcandle illumination (natural or artificial) should be provided in toilet rooms.

Separate toilet rooms from dressing rooms by tight, full-height walls or partitions.

Do not permit toilet rooms to open directly into food-processing areas; instead, separate them by a ventilated vestibule with two sets of self-closing doors.

The toilet rooms or privies should be kept clean and in good repair.

Toilet rooms and privies should be furnished with toilet tissue.

The lavatories should be provided with hot water (at least 110°F) either from a controlled temperature source with a maximum temperature of 120°F, or from a hot-and-cold mixing or combination valve. (Steam-water mixing or steam-water combination valves are not acceptable.)

Toilet rooms should be ventilated by a direct opening to the outside air, or by an approved mechanical ventilating system. (Exhaust fans, if used, should have a minimum capacity of 2 cubic feet a minute per square foot of floor area.) Air vents should be screened or have self-closing louvers.

Provide elongated water closets with open split seats in the following ratios:

Persons employed *Number*	Toilets provided *Minimum number*
1 to 9	1
10 to 24	2
25 to 49	3
50 to 100	5
Each Additional 30	1

c. Hand-washing units.

Locate hand-washing units (lavatories) conveniently and make sure that they meet the appropriate requirements discussed under the section on "Plant sanitation and cleaning provisions," page 26 (Fig. 10.)

Make the minimum size of bowl 16 by 16 by 9 inches, and supply each lavatory with hot and cold water delivered through a mixing faucet fixed at least 12 inches above the rim of the bowl so that an employee may wash his arms.

Locate liquid soap and sanitary towels in suitable containers at each wash basin.

d. Eating facilities.

Provide clean, well-lighted, and ventilated eating facilities that are separate from work areas and toilet areas.

If eating facilities are provided in the dressing room, set the space aside separate from the immediate locker area.

Figure 10.—An attractive, clean, well-lighted employee lavatory area.

Provide tables and chairs or benches, washing facilities, and drinking fountains.

Clean the area after regularly scheduled work breaks and lunch periods to prevent food particles from attracting vermin and insects.

II. PROCESSING RECOMMENDATIONS

We now have given detailed consideration to the guidelines on the plant —both its premises and its construction, including the processing facilities and the employee facilities. We turn next to the guidelines on the processing itself. In so doing, we consider the methods of guarding against microbial contamination of the plant and product and then give attention to the handling of the product.

A. Guarding Against Microbial Contamination

In guarding against microbial contamination, we are aided by a knowledge of certain procedures for testing for the presence of microbial contamination and of sanitation principles involved in microbial control.

1. Bacteriological Testing Procedures

The Food and Drug Administration is giving a great deal of attention to establishing microbiological standards for fishery products. Such products as fried fish sticks, fried fish cakes, precooked crab cakes, precooked breaded scallops, precooked clams, raw breaded shrimp, raw breaded oysters, and breaded fish and chips are currently under evaluation. Once FDA standards are published they are, of course, legal requirements and will take immediate precedence over any numbers suggested in the following section.

Have the microbiolgoical tests listed below (under "Microbial tests to be performed") made periodically on samples of the finished products from all processing lines. These tests will serve as a guide in determining whether you have a sanitation problem in your plant. Do not consider the numbers as being an absolute standard of product quality, but rather as being levels that, if exceeded, indicate that a more thorough microbiological survey of raw material, processing equipment, and personnel should be made. This survey will help you decide whether you do have an area that is a source of serious contamination or that could become one.

Here we are concerned specifically with five subjects: a) Directions for microbial tests, b) microbial tests to be performed, c) sampling, d) corrective action, and e) resurvey.

a. Directions for microbial tests.—Have the microbiological tests carried out according to the procedures given in "Standard Methods for Examination of Dairy Products": current edition, prepared by the American Public Health Association (1972). These procedures are suggested for fishery products but are *not* standardized for such products. There are still no generally recognized methods for testing fishery products, but the procedures given in "Standard Methods for Examination of Dairy Products" will prove generally satisfactory for the type of microbiological survey recommended in this section. Other publications that can be helpful in this area are the "Recommended Procedures for the Examination of Seawater and Shellfish," fourth (or current) edition which is also prepared by the American Public Health Association (1970), and the Food and Drug Administration's (1972) "Bacteriological Analytical Manual."

b. Microbiological tests to be performed.—The microbial tests to be performed include the following: (1) total plate count, (2) coliforms, (3) *Salmonella,* (4) *E. coli,* (5) coagulase positive staphylococcus, and (6) fecal coliform and coagulase negative staphylococcus.

(1) **Total plate count.**—Take remedial action if the total plate count exceeds 200,000 organisms per gram. Consider that the total plate count indicates the entire bacterial exposure of the product. Furthermore, consider that it also indicates the level of spoilage organisms present. Although a direct relation between total plate counts and organoleptic quality or storage life has not been established, excessive counts do indicate that the storage life of fresh fish with such counts will be reduced materially.

(2) **Coliforms.**—Take immediate remedial action if the MPN (most probable number) is more than 360 per gram. The presence of coliform organisms indicates contact of the product with water and soil contaminants and warns that the product may possibly be polluted with sewage.

(3) ***Salmonella.***—Take immediate remedial action if the sample is not free of this organism. *Salmonella* is a bacteria that causes food poisoning. The presence of this organism indicates human or animal contamination.

(4) ***E. coli.***–Take immediate remedial action if the MPN is greater than 50 per gram. This organism is one of the coliform group and is a specific indicator of fecal contamination. Although this organism does not cause disease, it indicates that the product probably has been contaminated with organisms that are pathogenic.

(5) **Coagulase positive staphylococcus.**—Take immediate remedial action if the MPN is more than 5 per gram. The test for this organism should be the confirmed test. The presence of the organism indicates human, infectious contamination. It is a toxin-producing organism that causes food poisoning. The organism is readily killed by heat, but the toxin is quite heat stable.

(6) **Fecal coliform and coagulase negative staphylococcus.**—Fecal coliform and coagulase negative staphylococcus are also considered by some health authorities. State and local regulations should be consulted for levels of these organisms.

c. Sampling.

Make the initial survey of the finished fresh or frozen product at the point where it is ready to leave the plant.

Sample precooked products before they enter the cooker. Cooking will destroy many organisms but not all toxins; for this reason, microbial tests on cooked products give a misleading indication of their microbial exposure.

Take samples separately and place them in sterile containers.

Store fresh samples at 33°F.

Store frozen samples at 0°F or lower.

Test all samples as soon as possible after they are taken.

If the results of any of the bacteriological tests exceed the suggested limits, make a complete microbiological survey of the plant.

Take samples of all raw material.

Take samples of the product after each stage of processing (that is, after initial washing, filleting, skinning, brining, tempering, and cutting of frozen blocks; after applying batter and breading; and after packing).

Take swabs of all equipment during processing and after cleaning up.

d. Corrective action.—From the results of the complete survey, take corrective action if any trouble spots were identified. Corrective action may range from a general cleanup of the entire plant to something as specific as cleaning up a single piece of equipment, discarding certain raw material, or having one of the employees change his personal habits.

e. **Resurvey.**—To determine the effectiveness of the corrective action, repeat the product survey after the corrective sanitizing and cleanup measures have been instituted. Make periodic surveys to determine if the plant-sanitation program is continuing to be effective or if new problems in sanitation have developed.

f. **Benefits of bacteriological testing.**—The greatest benefit to be desired from in-plant microbiological testing is to establish a base line for all segments of the operation from incoming raw material to finished product. Once this microbiological base line is known, then periodic tests will provide an indication as to the bacterial changes that are taking place within the plant as well as in raw material being received.

2. Plant and Personnel Sanitation

Having outlined the bacteriological testing procedures, we now consider plant and personnel sanitation. In so doing, we consider provisions relating to plant sanitation and cleaning and those relating to personnel practices.

a. **Plant sanitation and cleaning provisions.**—Keep in mind that, although proper sanitation is the direct responsibility of the plant manager, an effective sanitation program can be obtained only when every employee in the plant is instructed in proper sanitary precautions and is fully impressed with the reason for proper sanitation in terms of product quality and protection of the product from public-health hazards.

Plant sanitation requires the services of a sanitarian and adequate cleaning methods and facilities.

(1) **Sanitarian.**—Assign one person as a sanitarian for the plant. The sanitarian must be tactful and have good judgment and should be assigned sufficient authority to be effective in carrying out his duties. If the plant is large, assign one or more assistant sanitarians for specific work areas. Make the sanitarian responsible for supervision of all plant-cleaning operations. Have him thoroughly inspect all processing areas and equipment before each day's operation, and see that any deficiencies are corrected before operations are started.

(2) **Cleaning and cleaning facilities.**

(a) Cleaning.—To clean adequately, adopt a schedule and carry out the cleaning steps in proper sequence.

[1] Cleaning schedule.

Adopt a cleaning schedule for each area in the plant, and adhere to it unless conditions warrant more frequent cleaning or sanitizing operations. Thoroughly clean continuous-use equipment such as conveyors, filleting machines, flumes, batter and breading machines, cookers, and tunnel freezers at the end of each working shift, or oftener, if conditions indicate the need.

Clean batter machines and other equipment in contact with milk or egg products more frequently, depending on the temperature at which the batter is maintained, the type of material going into the batter (fresh or frozen), the ambient temperature of the work area, and the microbiological level of the raw materials and fish. Ascertain these factors, and design the cleaning schedule accordingly.

An example of such a schedule for a batter machine used for frozen fish portions in a moderate temperature work area might be: The sanitized machine is assembled at the start of working shift. At noon (or 4-h intervals) batter drained from the machine and batter reservoir flushed with clean water, a sanitizing solution, then cold water. At the end of the shift or work day, machine is disassembled and all parts cleaned and sanitized as outlined below under "Cleaning sequence."

Clean and sanitize portable equipment and utensils after they are used, and store them above the floor in a clean, dry location so that they are protected from splash water, dust, and other contaminants.

[2] Cleaning sequence.

Mechanically or manually remove loose dirt by scraping and brushing floors and equipment.

Rinse with cold or warm water. Because fish residues and other proteins coagulate at high temperature and may become baked onto the contact surface, remove these materials with water at temperatures below 100°F early in the cleaning process.

Wash with an acceptable detergent.

Rinse twice with hot water at a temperature of at least

170°F. Hot water is more effective than cold water in removing fats, oils, and inorganic material.

Sanitize with an acceptable bactericidal agent. Chlorine compounds are the most widely used—recommended strengths are given later. Other sanitizing agents approved for use in food-processing plants are also effective.

Rinse twice with hot water. A thorough rinse with potable water should follow any operation involving a chemical sanitizing agent.

(b) Cleaning facilities.—Here are considered detergents, sanitizing agents, single-service articles, and hand-sanitizing units.

[1] Detergents.—In using detergents, we are concerned about their characteristics and about which of them are approved for use with food products.

[*a*] *Characteristics of detergents.*

Keep in mind that the desirability of a detergent usually is determined by the degree to which it exhibits the following characteristics (Somers, 1949).

High wetting or penetrating action, which causes rapid washing away of the soil.

Good rinsability, which results in the detergent and soil being rinsed from the equipment freely and rapidly after the desired cleaning has been accomplished.

High emulsifying power for oils.

High deflocculating or dispersing power, to bring deposits of precipitates into suspension so that they can be washed away.

Water conditioning or sequestering properties in alkaline solutions, to prevent deposits on equipment of any calcium and magnesium compounds from the water.

Dissolving and neutralizing power, for the purpose of dissolving or neutralizing tenacious deposits and saponifying fats to make them soluble in water. Low corrosiveness to the surfaces on which they are used.

[b] *Approved compounds.*–Detergents and sanitizing compounds approved for use in food processing plants may be found in the current edition of "List of Chemical Compounds - Authorized For Use Under USDA Poultry, Meat, Rabbit, and Egg Products Inspection Programs," by U.S. Department of Agriculture (1968).

[2] Sanitizing agents.

[a] *Chlorine solutions.*

Use the following suggested concentrations of chlorine solutions in fish processing plants:

Use	Available chlorine *Parts per million*
Wash water	2-10
Rinse water on hands	50-100
Clean smooth surfaces (wash basin, urinals, glassware)	50-300
Clean smooth wood, metal or synthetic surfaces (new boxes, new table tops, conveyor belts, machines)	300-500
Rough surfaces (worn tables, old boxes, concrete floors, and walls)	1,000-5,000

Keep in mind that it is important to rinse with clear potable water after using any sanitizng agent and that, to prevent corrosion, it is especially important to rinse metal surfaces after chlorine solutions are used.

[b] *Iodophors.*

Iodophors are complexed iodine sanitizers. In complexing these sanitizers iodine is dissolved in synthetic detergents. This reduces the toxicity which causes skin irritation, staining, and odor found in other types of iodine solutions.

The amber color of the solution is an index of germicidal power. The solution works effectively as a sanitizer as long as the color lasts. Iodophors are particularly suitable for hand dips and for partially porous surfaces:

Use	Available iodine *ppm*
Hand dip	8-12
Smooth surfaces	8-35
Rough surfaces	125-200
Equipment and utensils	12-20

[c] *Quaternary ammonium compounds.*

These compounds come in many forms and in a wide variety of commercial products. They are less versatile than chlorine, but are better wetting agents and since they do not evaporate, provide a residual germicidal action. They are particularly effective in controlling mold growth on walls and ceilings of coolers. The major disadvantage of the compounds is that they leave a residual film. This residue must be removed from food processing surfaces before they are used. This is an FDA requirement.

There are many forms of these compounds. The label should be consulted for the recommended solution strength. Several generally suggested concentrates of Quaternary Ammonium Compounds are:

Use	Strength *ppm*
Cooler walls and ceilings	500-800
Hand dips	50
Equipment	200

(3) Single-service articles.

Store materials intended for one-time use, such as paper cups or towels, in closed containers, and dispense them singly and in such a manner as to prevent their being contaminated.

Provide closed containers for the disposal of such articles.

(4) Hand-sanitizing units.

Locate wash sinks and sanitizing hand dips outside of lavatories and adjacent to work areas, such as filleting lines of packing tables, where fish are handled.

Supply sanitizing dips with 100 parts per million of available chlorine or with 12 parts per million of available iodine. Keep filleting knives and steel in sanitizing solutions when not in use, and have each filleter rinse his hands and change knives frequently.

b. Personnel provisions.—Employee health and employee practices are important in controlling microbial contamination.

(1) Employee health.

Have all food-handling employees examined physically prior to their starting work at the plant and at least annually thereafter. Comply with local health requirements regarding the physical examination and see that each employee has a current and valid health certificate showing no evidence of any communicable disease. Have the employee take a physical examination before returning to work after any contagious illness.

Do not allow employees with open sores and lesions into food-processing areas.

(2) Employee practices.

Prohibit employees from eating, using tobacco in any form, and spitting in food-handling areas. Do not allow employees to wear jewelry, except plain wedding bands or rings and unadorned pierced earrings (not screw-on type) in food areas.

Breast pockets should not contain pens, pencils, or any other articles that may drop onto the products. Have all food handlers wear clean outer garments, preferably white, that cover personal clothing.

Have fish filleters wear easily cleanable rubber or plastic aprons or coveralls and boots. Such garb should be worn by personnel working with fresh fish or on cleanup crews using large amounts of water. Require that all clothing worn during working hours be clean, and maintain an adequate supply of replacement garments.

Have all employees wear head coverings (caps or hairnets that cover or hold the hair in place.) Filleters should not be allowed to go into or through the packing room for any purpose. (An exception may be made in small operations, where an employee may work in both the packing room and the filleting room. In such cases, the employee should be required to change aprons and wash his hands thoroughly before entering the packing room.)

Require that each employee wash and sanitize his hands after each absence from a work station. When rubber gloves are worn, have them washed and sanitized in the same manner.

Hand dips should be located as close as possible to the work station in order to avoid recontamination after the employee has washed and sanitized his hands.

B. PRODUCT HANDLING

In our guidelines on processing, we now have completed our suggestions for guarding against microbial contamination. We turn now to our guidelines on how to handle the product. Here, we consider the receiving of the new raw material and the processing of it.

1. Receiving Raw Materials

By raw materials, we mean both the fish and any other raw materials used in processing.

a. Fish.—We consider first the fresh fish and then the frozen fishery products.

(1) Fresh fish.

Check fresh fish for sign of spoilage, off odors, and damage upon their arrival at your plant. Discard any spoiled fish.

Immediately move fresh fish under cover to prevent contamination by insects, sea gulls, other birds, and rodents. If the fish are to be scaled, scale them before you wash them.

Unload the fish immediately into a washing tank. Use potable, nonrecirculated water containing 20 parts per million of available chlorine and chill to 40°F or lower. Spray wash the fish with chlorinated water after taking them from the wash tank (Fig. 11).

If incoming fresh fish cannot be processed immediately, inspect them, cull out the spoiled fish, and re-ice the acceptable fish in clean boxes; then store them preferably in a cold room at 32° to 40°F or, at least, in an area protected from the sun and weather and from insects and vermin. Wash, rinse, and steam-clean carts, boxes, barrels, and trucks used to transport the fresh fish to the plant if any of these are to be used again. Reusable containers should be rinsed again with chlorinated or potable water just before use. *Note:* wooden boxes and barrels should not be reused. It is virtualy impossible to satisfactorily sanitize used wooden containers such as fish boxes and barrels. If disposable-type containers are used, rinse them off and store them in a screened area until you remove them from the premises.

(2) Frozen fishery products.

Use a loading zone that provides direct access to a refrigerated room.

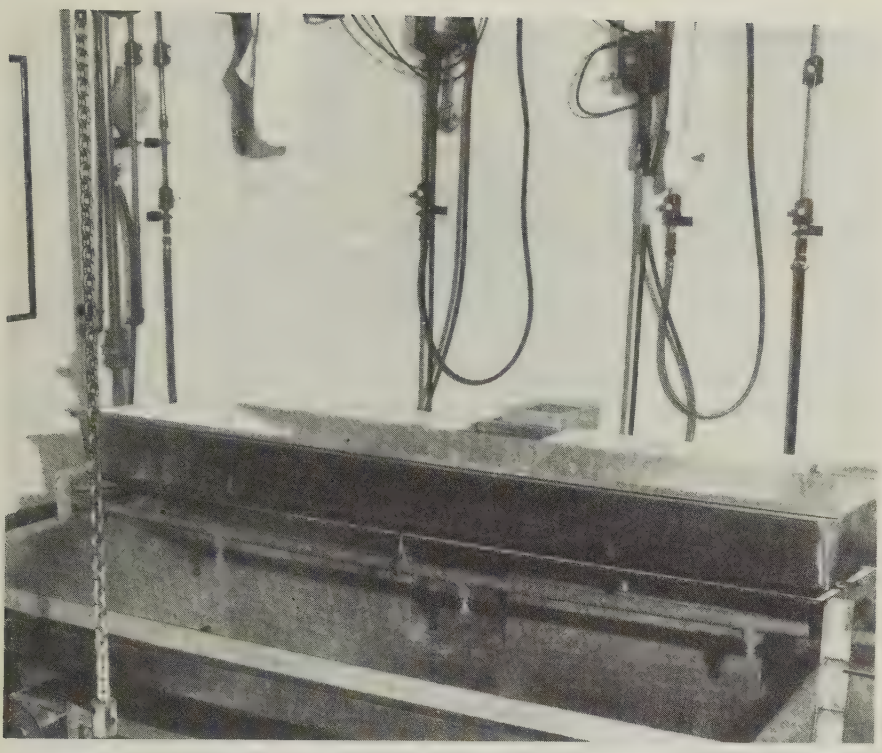

Figure 11.—Fish coming into the plant are placed in this wash tank (note the spray headers) from which they are carried by conveyor to the filleting line.

Check the temperature of the product at several areas in the load. When the product arrives, it should be 0°F or lower.

Place the product on pallets and assign a freezer lot number to it to ensure that the rule of "first-in, first-out" is observed.

Keep the freezer storage at −10°F or lower, and use a separate blast freezer capable of rapidly lowering to −20°F any product that arrives at a temperature higher than 0°F.

b. Other raw material (dry).

Unload other raw material in an area separate from the fresh or frozen products.

Store the material in a dry, ventilated area on pallets or shelves that will keep the material away from the floors and the walls.

Screen the storage area adequately to prevent entrance of insects and vermin during loading or unloading operation.

2. Processing Raw Material

Keep in mind that fish is a highlv perishable food. The primary cause of deterioration of fish flesh and the resulting loss of quality is bacterial contamination. Every step in the recommendations for sanitary plant operation and fish-handling procedures is designed to reduce this contamination and thereby protect the health of the consumer and maintain the quality of the product. The basic rules for handling a fishery product are:

Keep the product cool, as near 32°F as possible for fresh fish and below 0°F, preferably −10°F, for frozen fish. Cooling the fish will retard but not completely stop spoilage. Since spoilage is irreversible, low temperature can only reduce the rate of future deterioration; it cannot reverse spoilage that has already taken place.

Keep it clean.

Keep it moving. It is the combination of time and temperature that permits bacteria to grow and build up. Even under optimum conditions, quality will be gradually lost, so you should get the product into the consumer's hands as rapidly as possible.

a. Fresh fish.

Handle incoming fresh fish as was described in the section on "Receiving raw materials," page 32.

Cool the filleting room to 50°F or lower. If the room is not cooled, then ice the fish so as to maintain their internal temperature of 40°F or lower (Fig. 12).

During hand-filleting operations, scrub the filleting boards at least twice a day. Use water containing 2 to 5 parts per million of available chlorine to flush continuously the filleting boards and conveyors used to transport the whole fish.[2]

When cutting fillets by hand, handle them so that the cut surface does not come in contact with the filleting board; then immediately place them on a fillet conveyor or in a container.

Furnish filleting machines with a continuous supply of water on the surfaces in contact with the fish. Have the fillets discharged directly onto a conveyor.

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[2]The increasing attention being given by the Environmental Protection Agency to reducing water effluents from all sources may restrict the use of continuous flow water systems in the future.

Use a machine to prepare skinless fillets and spray water on the skinning machinery.

Complete all trimming operations before sending the fillets to the final wash.

Because certain species of fish (such as cod, ocean perch, and some Pacific rockfish) may contain parasites, candle the fillets from these fish before brining them in the final wash. Do the candling on a clean glass surface well illuminated from below. Because heat from the lights may cause bacteria to grow rapidly on the surface of the candling table, clean the surface thoroughly and sanitize it frequently. Continuously flush it with chlorinated water.

A brining tank, to be effective, must be used correctly. Use brine as a final wash in order to help reduce the loss of moisture. A brine made up of 10% by weight of sodium chloride (food grade salt), or 38° salometer, is a good general purpose strength as long as exposure of the fillet to the brine is limited to approximately 20 sec. Chill the brine to 35°F or lower and chlorinate it. A chlorine residual of 3-5 ppm should be maintained.

Figure 12.—Fish well iced while awaiting processing.

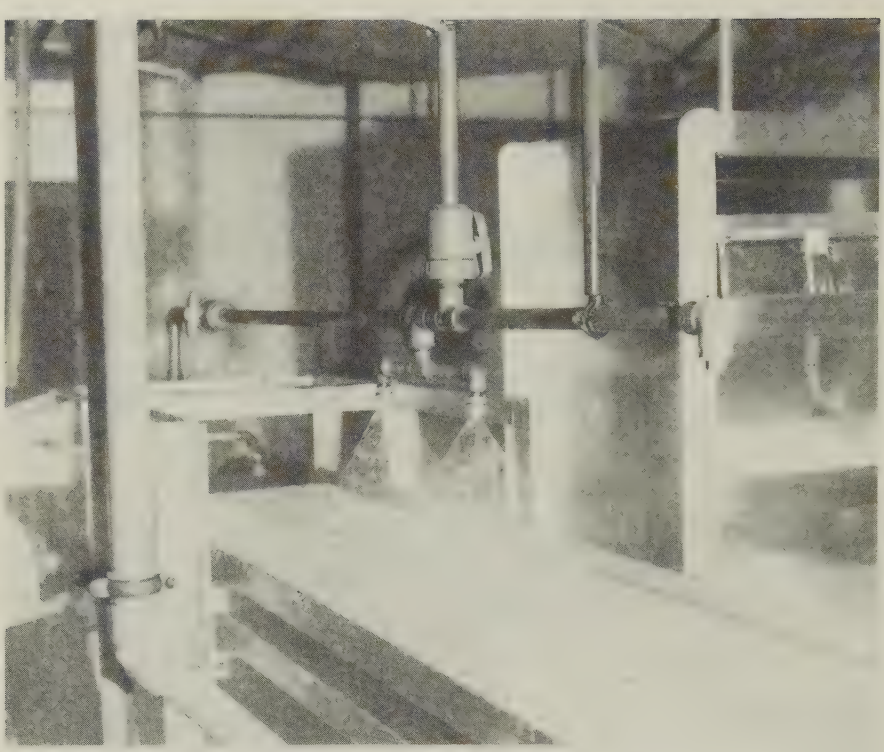

Figure 13.—Spray nozzles set at the end of a stainless steel fillet conveyor.

Because of the buildup of organic material in the solution, this can only be done by having a continuous metered flow of chlorine. Change the brine solution at least once an hour, so that it will decrease bacterial contamination. Convey the fillets through the tank so as to regulate their time of exposure to the brine; after they leave the tank, pass them through a multijet mist spray (Fig. 13). Keep in mind that the strength of brine and exposure time should depend on the species of fish being handled. Only mildly brine the fillets of fatty fish, especially those fillets that are to be frozen; otherwise, the residual salt on the fillets will accelerate the development of rancidity during storage. A fine spray wash can be used in conjunction with the brine tank or in place of brining. The spray should be gentle enough not to damage the fillets yet in sufficient volume to give them a thorough wash.

See that fresh fillets that are to be packed in bulk have an internal temperature no higher than 35°F before the fillets are packed in a bulk container. If need be, use an adequately refrigerated brining tank as a prechiller. Prompty pack and ice well the prechilled fillets (Fig. 14) or place them in a cold-storage room at 30° to 35°F.

Promptly pack fillets that are to be frozen, and place them in a freezer in less than 30 min after they are packed. If it is necessary to transport the fillets to another building for freezing, transport them under refrigerated conditions if the elapsed time from packing to entering the freezer exceeds 30 min. This is particularly important during the warm summer months. Do not expose the packaged fillets to sun and dirt.

b. Frozen fishery products.

Handle incoming frozen fish as was described in the section on "Receiving raw materials," page 32.

Where frozen fishery products such as fish blocks must be tempered (brought up to a higher temperature) before being processed, temper them in a refrigerated room under controlled conditions. (Uncontrolled tempering in work areas causes blocks on the outside of the load to become excessively warm while the blocks at the center of the load remain too cold for efficient processing.) (Recent studies indicate that

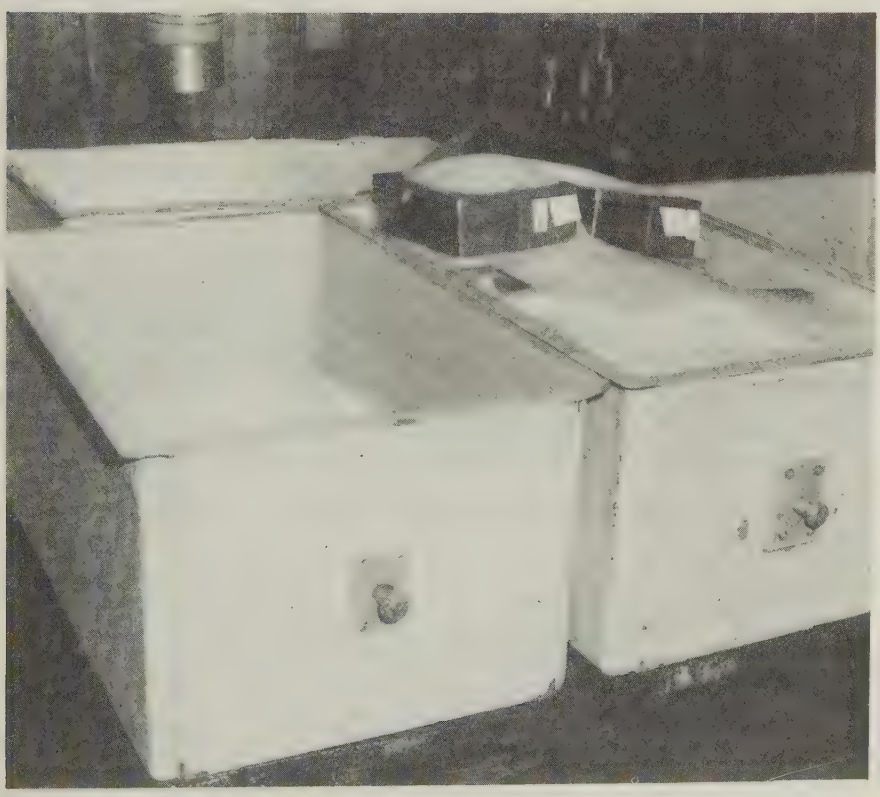

Figure 14.—Fillets packed in tins and iced awaiting shipment.

the use of microwave ovens may provide a rapid, easily controllable method of tempering fish blocks or thawing such products as frozen shrimp. The use of such equipment can be investigated by contacting manufacturers of microwave units.) Once the blocks are tempered to the desired temperature (not higher than 20° F), process them as soon as possible. Slake out, in refrigerated water, blocks or bulk packs of fillets or whole fish that must be thawed and separated for further processing. Prechill the water to below 40°F. Remove the fish or fillets as soon as they are thawed sufficiently to be processed. Change the water and clean and sanitize the tanks before you put more fish in them.

Good product handling practices require that breading lines be given particular attention. Maintain the temperature of the batter below 40°F whenever possible and never allow it to go above 45°F. Discard all unused batter at the meal break and at the end of each work shift, and clean and sanitize the batter container before reloading it. Discard unused breading at the end of each work shift. Place drip pans and dust shields around breading and batter machines. Remove any spillage from the floors at once.

When processing precooked products, pass cooking oil through a continuous filter to remove any food particles in the oil. Locate adequate exhaust fans in the working areas to remove smoke, odors, and excess heat. Pass precooked products directly from the cooker to a freezer before packing them. Maintain temperature-control charts for all cookers.

Handle all frozen products as expeditiously as possible to prevent them from thawing. Do not allow the time between bringing the frozen blocks to the processing area and placing the finished product in the freezer to exceed 1 h. (In a well laid-out plant, this time will be less than 30 min.) Because of this short time interval, the work area need not be refrigerated, but prevent it from becoming warmer than 75°F.

Show the date of packing on the primary code containers of all finished products.

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